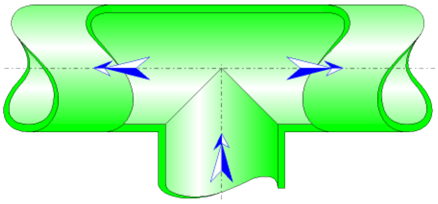
Symmetric dividing sharp-edged T-junction (welded type) Circular Cross-Section (IDELCHIK)



Model description:

This model of component calculates the minor head loss (pressure drop) generated by the flow in a symmetric dividing sharp-edged T-junction welded type.

The head loss by friction in the inlet and outlet piping is not taken into account in this component.

Model formulation:

Cross-sectional area of the right branch (m^2):

$$F_{1s} = \pi \cdot \frac{D_s^2}{4}$$

Cross-sectional area of the left branch (m^2):

$$F_{2s} = \pi \cdot \frac{D_s^2}{4}$$

Cross-sectional area of the common branch (m^2):

$$F_c = \pi \cdot \frac{D_c^2}{4}$$

Volume flow rate in the common branch (m^3/s):

$$Q_c = Q_{1s} + Q_{2s}$$

Mean velocity in the right branch (m/s):

$$w_{1s} = \frac{Q_{1s}}{F_{1s}}$$

Mean velocity in the left branch (m/s):

$$w_{2s} = \frac{Q_{2s}}{F_{2s}}$$

Mean velocity in the common branch (m/s):

$$w_c = \frac{Q_c}{F_c}$$

Mass flow rate in the right branch (kg/s):

$$G_{1s} = Q_{1s} \cdot \rho$$

Mass flow rate in the left branch (kg/s):

$$G_{2s} = Q_{2s} \cdot \rho$$

Mass flow rate in the common branch (kg/s):

$$G_c = Q_c \cdot \rho$$

Reynolds number in the right branch:

$$\mathrm{Re}_{1s} = \frac{w_{1s} \cdot D_s}{\nu}$$

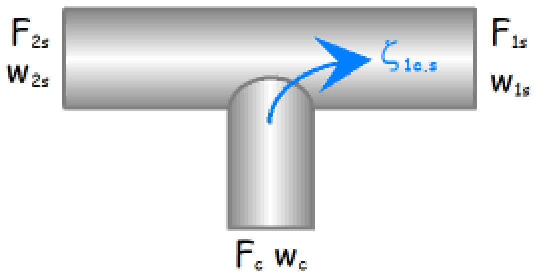
Reynolds number in the left branch:

$$\mathrm{Re}_{2s} = \frac{w_{2s} \cdot D_s}{\nu}$$

Reynolds number in the common branch:

$$\mathrm{Re}_c = \frac{w_c \cdot D_c}{\nu}$$

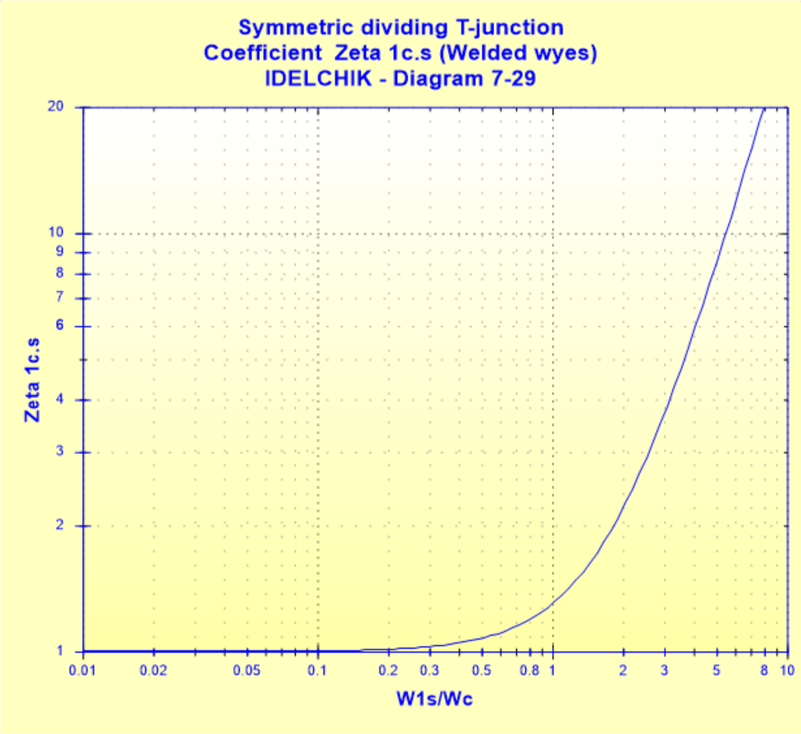
Pressure loss coefficient of the right branch (based on mean velocity in the common branch):



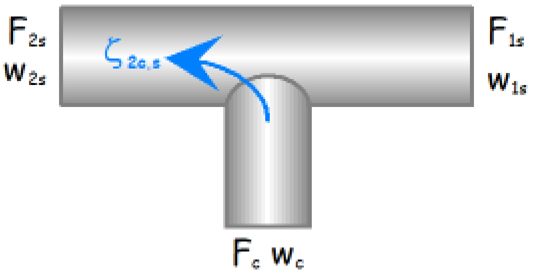
$$\zeta_{1c.s} = 1 + k_1 \cdot \left(\frac{w_{1s}}{w_c}\right)^2$$

([1] diagram 7.29 – Division of flow)

with: k_1 = 0.3



Pressure loss coefficient of the left branch (based on mean velocity in the common branch):

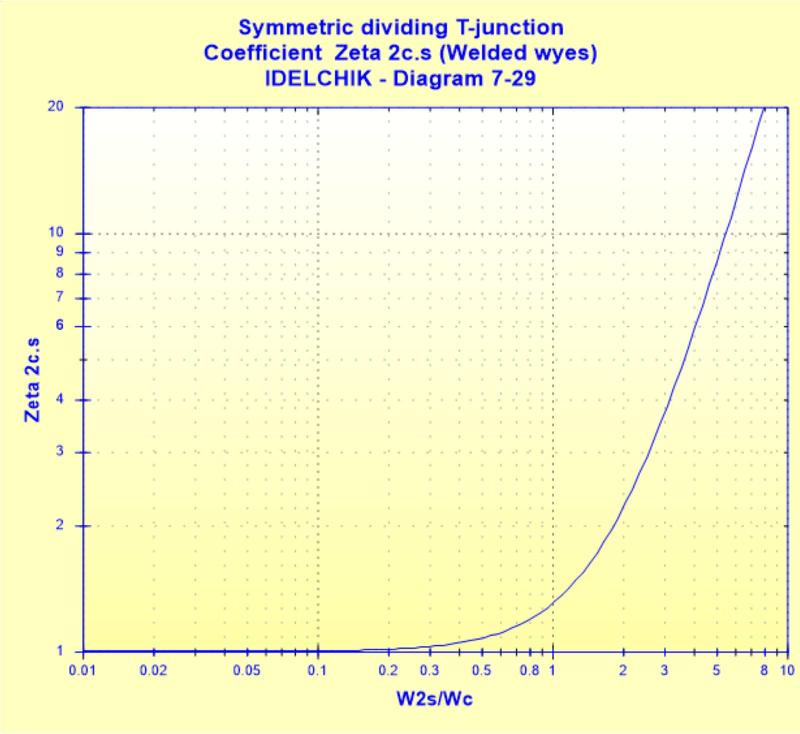


Note: for the left branch, the formulas are the same as those of the right branch, with subscript 2 instead of subscript 1.

$$\zeta_{2c.s} = 1 + k_2 \cdot \left(\frac{w_{2s}}{w_c}\right)^2$$

([1] diagram 7.29 – Division of flow)

with: k_2 = 0.3



Pressure loss in the right branch (Pa):

$$\Delta P_{1c.s} = \zeta_{1c.s} \cdot \frac{\rho \cdot w_c^{\ 2}}{2}$$

Pressure loss in the left branch (Pa):

$$\Delta P_{2c.s} = \zeta_{2c.s} \cdot \frac{\rho \cdot w_c^{\ 2}}{2}$$

Head loss of fluid in the right branch (m):

$$\Delta H_{1c.s} = \zeta_{1c.s} \cdot \frac{w_c^{\ 2}}{2 \cdot g}$$

Head loss of fluid in the left branch (m):

$$\Delta H_{2c.s} = \zeta_{2c.s} \cdot \frac{w_c^{\ 2}}{2 \cdot g}$$

Hydraulic power loss in the right branch (W):

$$Wh_{1s} = \Delta P_{1c.s} \cdot Q_{1s}$$

Hydraulic power loss in the left branch (W):

$$Wh_{2s} = \Delta P_{2c.s} \cdot Q_{2s}$$

Symbols, Definitions, SI Units:

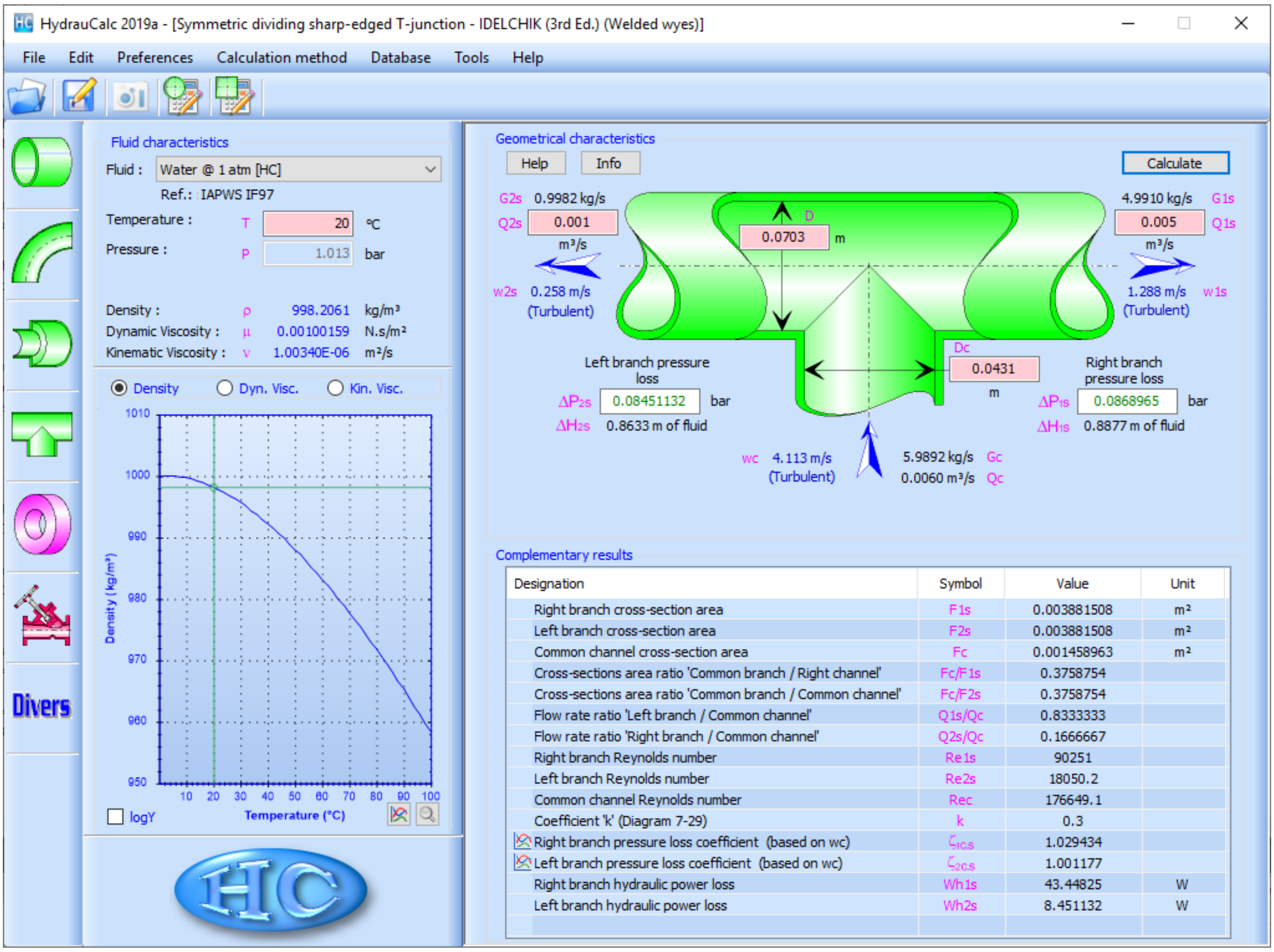
D_s	Diameter of the right and left branches (m)
D_c	Diameter of the common branch (m)
F_{1s}	Cross-sectional area of the right branch (m^2)

F_{2s}	Cross-sectional area of the left branch (m^2)
F_c	Cross-sectional area of the common branch (m^2)
Q_{1s}	Volume flow rate in the right branch (m^3/s)
w_{1s}	Mean velocity in the right branch (m/s)
Q_{2s}	Volume flow rate in the left branch (m^3/s)
w_{2s}	Mean velocity in the left branch (m/s)
Q_c	Volume flow rate in the common branch (m^3/s)
w_c	Mean velocity in the common branch (m/s)
G_{1s}	Mass flow rate in the right branch (kg/s)
G_{2s}	Mass flow rate in the left branch (kg/s)
G_c	Mass flow rate in the common branch (kg/s)
Re_{1s}	Reynolds number in the right branch ()
Re_{2s}	Reynolds number in the left branch ()
Re_c	Reynolds number in the common branch ()
$\zeta_{1c.s}$	Pressure loss coefficient of the right branch (based on mean velocity in the common branch) ()
$\zeta_{2c.s}$	Pressure loss coefficient of the left branch (based on mean velocity in the common branch) ()
ΔP_{1s}	Pressure loss in the right branch (Pa)
ΔP_{2s}	Pressure loss in the left branch (Pa)
ΔH_{1s}	Head loss of fluid in the right branch (m)
ΔH_{2s}	Head loss of fluid in the left branch (m)
Wh_{1s}	Hydraulic power loss in the right branch (W)
Wh_{2s}	Hydraulic power loss in the left branch (W)
ρ	Fluid density (kg/m^3)
ν	Fluid kinematic viscosity (m^2/s)
g	Gravitational acceleration (m/s^2)

Validity range:

- turbulent flow regime ($Re_c \geq 10^4$)
- diameter of common branch (D_c) ≤ diameter of right and left branches (D_s)

Example of application:



References:

[1] Handbook of Hydraulic Resistance, 3rd Edition, I.E. Idelchik